SENSORS & CONTROLS

Project Fact Sheet

REMOTE AUTOMATIC MATERIAL ON-LINE SENSOR

BENEFITS

- The power cost of the system will be less than $1 per hour, and no cryogenic fluids or hazardous radiation will be used.
- The system will enable coal-fired power plants to adjust air flow to adjust burn conditions in real time with an estimated increase in plant efficiency of 0.5 percent or an annual savings of $500,000 per year for a large plant.
- In food processing applications, energy savings could range from 5 to 15 percent by preventing excessive drying of products such as potatoes and grains; savings in these two segments alone are projected at nearly 0.01 quad BTU per year.

APPLICATIONS

Applications for the monitor include use for on-line determinations of moisture and hydrocarbon content in coal. In addition, improved dryer control and substantial energy savings could be realized in many food processing and wood drying operations. The sensor could also be used for determinations of several properties of polymers, such as chain length and crosslink density. With slight modifications for pipelines, it could be used to measure hydrogen and asphaltene content in petroleum. It could also be used to determine the hydration state of bauxite ore used for aluminum production.

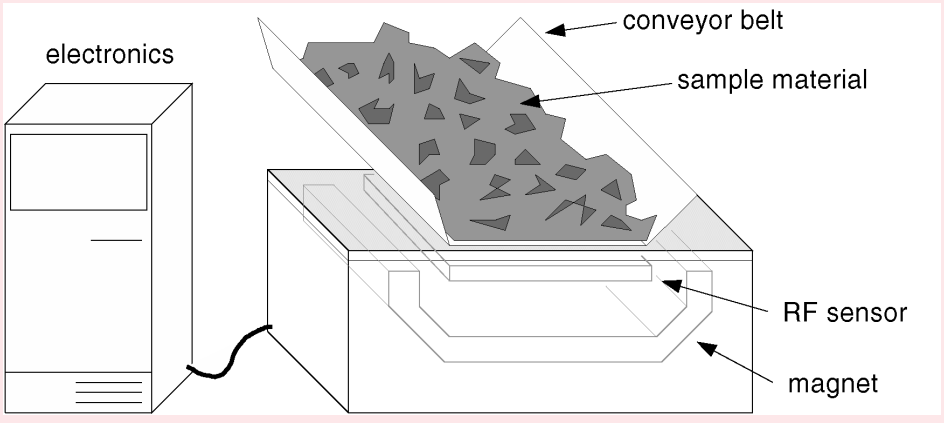
A SINGLE-SIDED MAGNETIC RESONANCE SYSTEM WILL PERFORM CONTINUOUS DETERMINATIONS OF HYDROGEN CONTENT IN MATERIALS ON A CONVEYOR BELT

The proposed technology is a single-sided magnetic resonance system designed to perform continuous measurements on materials on a conveyor belt as they pass over the sensor. The system will allow properties of the material such as hydrogen content and solid-to-liquid ratio to be measured.

The system includes a sensor head comprised of a U-type electromagnet that is mounted under a conveyer belt. The magnetic field is shaped to produce a spherical or elongated ellipsoidal field sensing region at the downstream end of the magnet. A radio-frequency (RF) coil excites the sample material and subsequently detects the proton magnetic resonance signals from the material. The system can be adjusted to give either a homogeneous field for volume averaged data or a gradient for vertically profiled data.

The system is intended for use by companies whose materials contain hydrogen. It could function with nonconducting materials on a conveyor belt or for materials contained in a nonconducting, non-ferromagnetic tube or pipe. Projected applications include determinations of moisture content of coal, wood chips, food materials, and ores. Other possibilities include determinations of the hydrogen content of coke and crude oil.

MAGNETIC RESONANCE SYSTEM



Sketch of system components. The electronics enclosure houses the computer, RF electronics, and magnet power supply. The magnet and RF coil will be situated underneath the moving conveyor belt.

Project Description

Goal: Develop a magnetic resonance system that will enable manufacturers to measure properties of their materials on-line using a non-contacting sensor without the use of hazardous radiation.

The key innovative aspects of the proposed system are the single-sided design of the magnet and RF system as well as the solid/liquid sensing procedure. Moderately high RF power levels and good RF field uniformity are required; however, prior Quantum Magnetics products have employed much higher RF power levels. Interference from signals from the conveyer belt material will be minimized by arranging the magnetic field values at the belt locations to be far off resonance or by use of a depolarization technique. Other problems to be addressed include nonuniform vertical distribution of materials on the conveyer belt and RF interference.

Samples of coal, bauxite, and wood chips will be tested to determine their magnetic resonance parameters. These parameters will then be used to design the magnetic resonance system so that the moisture content of coal can be determined to within 0.25 percent of total weight, different hydration forms of bauxite can be discerned, and the fiber versus water content of wood chips can be measured. The system will then be constructed and tested as described below.

Progress and Milestones

- This project was selected through the Sensors and Controls Program FY00 solicitation and was awarded in January 2000. All tasks are scheduled for completion in 36 months, with go/no-go criteria established for the beginning of the second and third years.
- Phase I of the project will consist of four tasks as well as a report to be completed by the end of the first year. The four tasks are:
  a) interview prospective industrial users to determine their on-line measurement needs,
  b) perform magnetic resonance measurements on coal, bauxite, and wood chip samples to determine the parameters needed for the sensor design,
  c) design and model the magnet and RF coil for the sensor, and
  d) prepare engineering drawings and quotes.
- Phase II of the project will proceed if the final design has been shown to satisfy at least two of the industry measurement needs. The second year of the project will be devoted to the following tasks:
  a) procure and fabricate the components of the system,
  b) assemble the system, and
  c) test and demonstrate the system under laboratory conditions.
- The final year of the project will proceed if the laboratory tests in year two have been satisfactory. The tasks projected for this year include:
  a) develop calibrations, protocols, and data on measurement speed and accuracy using sample materials from at least two industries,
  b) demonstrate the system for on-line measurements at several industrial sites, and
  c) prepare a final report that documents the design, test data, and application information obtained throughout the program.

Project Partners

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May 2000